SITE CHARACTERIZATION AND ANALYSIS PENETROMETER SYSTEM TECHNIQUES

TECHNOLOGY DESCRIPTION

For many characterization activities, cone penetrometer techniques are favored over conventional drilling activities due to cost, schedule, or safety issues. The U.S. Department of Energy (DOE) Site Characterization and Analysis Penetrometer System (SCAPS) truck is currently located at the Savannah River Site (SRS) and is used primarily for the evaluation and demonstration of innovative Cone Penetrometer Test (CPT) sensors. In order to receive end-user or regulatory acceptance, new technologies, especially those that address difficult characterization problems, often require systematic testing under progressively more challenging conditions. Field-testing is the only way to test the robustness of technologies in a variety of hydrogeologic settings and to develop reliable, comparative unit cost and performance data. The main purpose of the activities funded currently under this task is to extend the capability of CPT truck-based systems for direct, *in situ* detection of Dense Non-Aqueous Phase liquids (DNAPLs). During the last 18 months, multiple sensors have been developed and a DNAPL characterization toolbox has been developed that provides a relatively robust system for the *in situ* detection of DNAPLs in real time,. The technologies are evaluated and implemented at Environmental Restoration Waste sites, and the results are used to address real characterization needs. During FY 1999, the following activities are being emphasized:

- The DNAPL characterization toolbox technologies will be evaluated and implemented at the Interagency DNAPL Consortium (IDC) test site at Cape Canaveral Air Station in Florida. The IDC site was selected as the location for a joint U.S. Environmental Protection Agency (EPA, U.S. Department of Defense (DoD), and DOE evaluation of innovative DNAPL remediation technologies. Technologies to be implemented include the EIC Inc. (EIC) Raman System and the GeoVis™ Soil Video Imaging System. In addition, a new commercial sensor developed for the semi-quantitative determination of high concentrations of dissolved-phase volatile organic compounds (VOCs) will also be evaluated at SRS. This tool is effective for a wide range of concentrations of VOCs and will fill a need within the DNAPL toolbox.

U.S. Department of Energy (DOE) Site Characterization and Analysis Penetrometer System (SCAPS) Truck at the Interagency Dense Non-Aqueous Phase Liquid (DNAPL) Consortium Site at Cape Canaveral Air Station

- Technical assistance will be provided to technology vendors to implement new technologies at SRS. During FY 1998, three technologies developed with funding from the FETC were implemented at SRS. In FY 1999, funding will be used to provide engineering and technical support for an implementation of the Science and Engineering Associates, Inc. (SEA) Cone Permeameter™ and the EIC Internal Reflectance Sensor.

TECHNOLOGY NEED

The cone penetrometer is a cost-effective and rapid tool for environmental site characterization in unconsolidated and semi-consolidated soil formations. In its standard configuration, the cone penetrometer is recognized as the most efficient tool for delineating lithology and stratigraphy in sedimentary formations. Currently, many CPT sensors and probes are under development that will extend the capabilities of CPT trucks. These tools will enable the real-time detection and processing of subsurface contamination data during operations. Although many of these sensors can provide better information in a cost- and time-effective manner, they are often not chosen by environmental line organizations due to the limited availability of independent cost and performance data. The activities of this task are focusing on collecting cost and performance data as well as providing technical and engineering assistance in the application of these technologies at DOE sites with real problems.

During FY 1999, the sensors chosen for evaluation under this project target a very high priority DOE need for characterizing and monitoring areas with DNAPL contamination in the subsurface. Residual industrial solvents are currently the most significant challenge for the successful completion of many large groundwater and soil cleanup efforts. Slowly dissolving DNAPLs provide a major source of groundwater contamination for hundreds of years and traditional sampling approaches generally are not successful at locating DNAPLs. Adding to the challenge, DNAPLs are very difficult to characterize in the subsurface–especially when they are found in dispersed blobs as is typical at many sites. The current DOE Site Technology Needs document identifies over 20 waste sites where the characterization of DNAPLs is a priority. The current baseline method for DNAPL characterization involves collecting a large number of sediment cores, a process that is expensive, time-consuming, and has the potential for creating pathways that enhance the downward migration of contaminants. The identification of successful techniques for *in situ* DNAPL characterization will significantly reduce costs and substantially improve the quality of characterization and monitoring efforts at sites contaminated or potentially contaminated with DNAPLs.

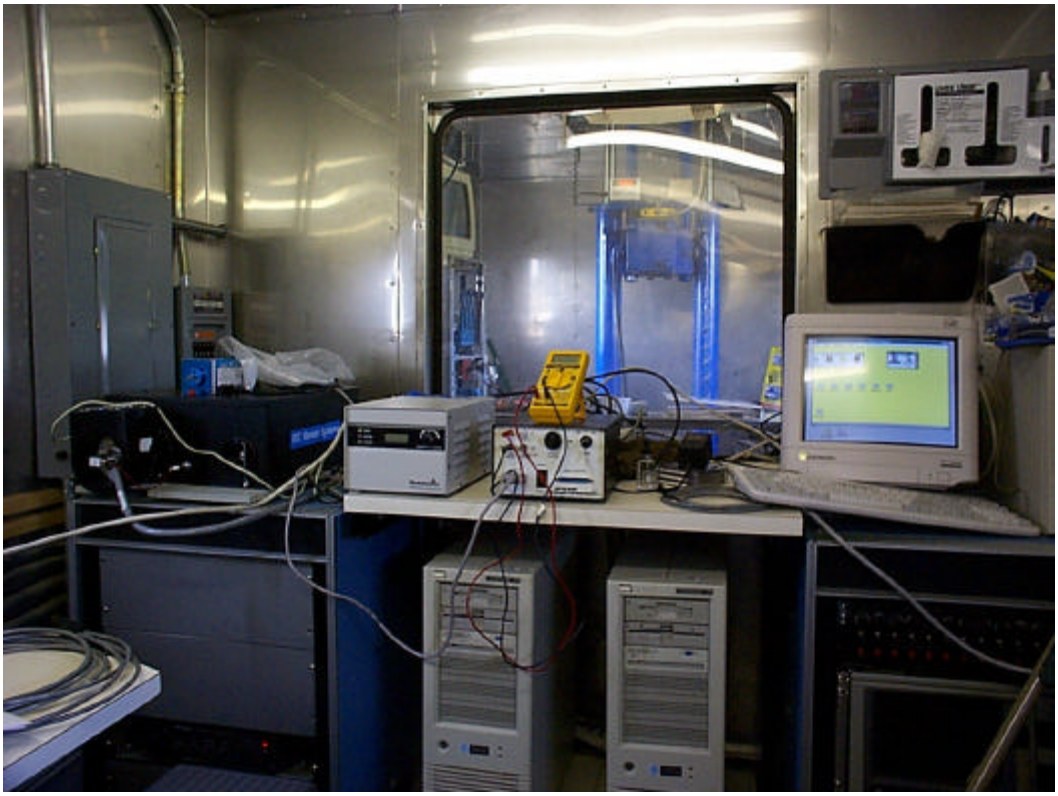
Applicable Site Technology Coordination Group Need Statements:

- SR99-3021 - Alternative Sample Collection and Well Installation Technology That Eliminates or Significantly Reduces Aqueous or Non-Aqueous Investigative Derived Waste (IDW)
- OK99-01 - Characterization and Removal of DNAPLs and Light Non-Aqueous Phase Liquids (LNAPLs) from Soil and Groundwater
- RF-ER14 - Characterization/Detection/Verification of Non-Aqueous Phase Liquids (NAPLs)
- Chemical Form and Mobility of Dense, Non-Aqueous Phase Liquids in Hanford Subsurface Transport of Contaminants RL-SS25-S
- ORHY-01a - Dense Non-Aqueous Phase Liquid (DNAPL) Source Characterization, Containment, and Treatment
- ORHY-01b - Dense Non-Aqueous Phase Liquid (DNAPL) Source Characterization, Containment, and Treatment
- ORHY-01 - Dense Non-Aqueous Phase Liquid (DNAPL) Source Characterization, Containment, and Treatment
- SR99-3017 - Dense Non-Aqueous Phase Liquid (DNAPL) Characterization and Remediation Technologies

TECHNOLOGY BENEFITS

The use of the SCAPS truck for environmental characterization and monitoring is favored over baseline drilling and sampling because in many situations, this CPT system:

- Provides continuous, real-time, subsurface information to aid in site characterization operations as they progress.
- Minimizes disturbance to the subsurface as no drilling fluids are used and the push-hole diameters are quite small (approximately 1 to 2 inches in diameter).
- Costs considerably less than conventional drilling and sample analysis methods.
- Offers the advantage of real-time data analysis so that the push location can be selected based on the results of holes already pushed.
- Can be used with sensors to measure various types of chemical contaminants and other physical characteristics of the subsurface.
- Is safer than conventional drilling because worker exposure is minimized due to faster subsurface access and the minimal amounts of waste generated.
- Makes possible the rapid and cost-effective definition of contaminant plumes thus enabling more accurate placement of remediation systems and monitoring wells.



Raman Spectroscopic Equipment in the Instrumentation Room of the U.S. Department of Energy (DOE) Site Characterization and Analysis Penetrometer System (SCAPS) Truck.

This year's evaluation activities focus on extending the capability of CPT systems for the direct detection of DNAPLs. Combining the qualitative information for multiple sensors may allow for the development of a relatively robust system for the real-time detection of DNAPLs.

In addition, field evaluation and implementation assistance will be provided to the DOE's Federal Energy Technology Center (FETC) for three of their environmental technologies that are at the technology demonstration stage of development. In FY 1997, the Savannah River Technology Center (SRTC) evaluated four FETC technologies, three of which are now in use by end-users at the SRS.

TECHNOLOGY CAPABILITIES/LIMITATIONS

When considering the selection of CPT at a particular site, the technology should be compared with the standard drilling and chemical analysis procedures in use at the site. CPT methods will not replace standard sampling and analysis for site characterization and monitoring, but they will provide a way to optimize sample collection and analysis. The use of CPT is dependent on appropriate geologic conditions to ensure penetration to the required depths.

The continuous nature of CPT investigations allows the use of screening technologies, especially contaminant sensors, to measure information on a depth-discrete scale. These technologies provide the most accurate possible information about the precise intervals where contamination occurs, leading to optimized remediation design. The real-time nature of the information allows for better use of characterization and monitoring resources and improves the quality of the characterization. The CPT technologies are limited to unconsolidated sediments and to the maximum depth capability of the CPT truck. The contaminant data are also limited by the lack of regulatory acceptance and are best used to optimize subsequent characterization and remediation.

Currently, a baseline system for *in situ* detection of DNAPLs does not exist. Combining the information from multiple sensors using a weight-of-evidence approach should provide a robust, real-time system for the direct detection of DNAPLs.

COLLABORATION/TECHNOLOGY TRANSFER

This work is a collaborative effort between various federal agencies, universities, and private industry. Principal partners include: Applied Research Associates, Inc.; EIC Inc.; Cape Canaveral Air Station; National Aeronautics and Space Administration (NASA); Space and Naval Warfare Systems Center, DoD; and Science and Engineering Associates, Inc.

ACCOMPLISHMENTS AND ONGOING WORK

FY 1998/1999 Evaluations and Deployments

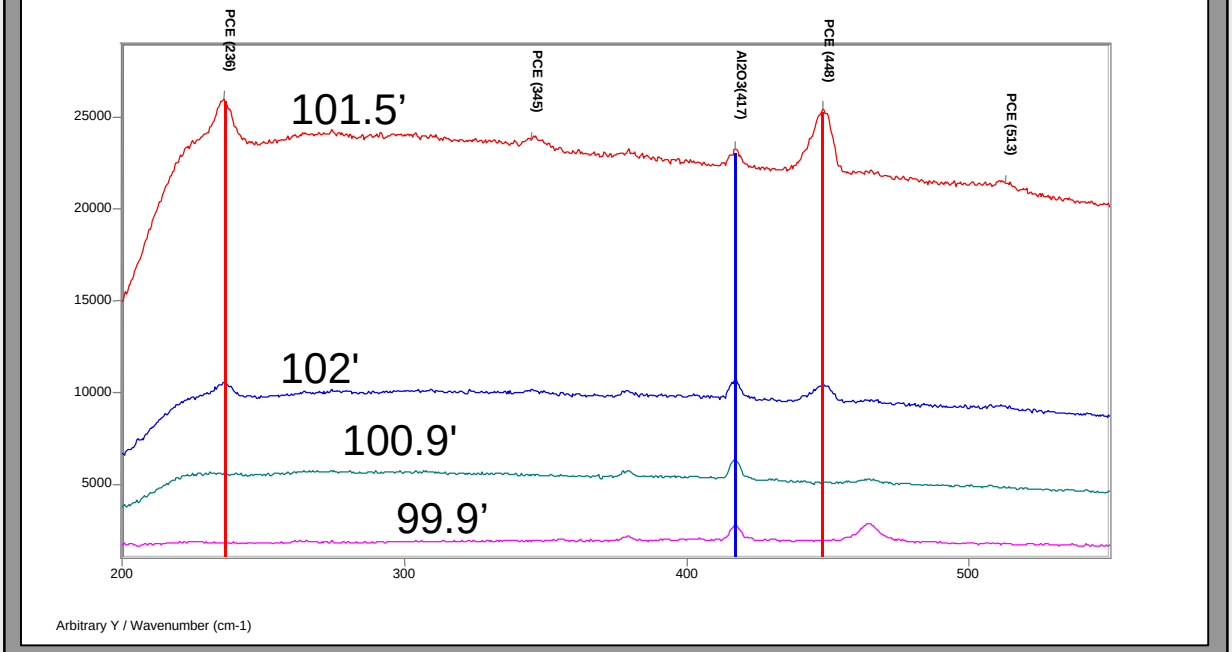
Raman Spectroscopy (EIC, Lawrence Livermore National Laboratory) for DNAPL Detection:
- M-Basin, 321-M at SRS (February and June 1998)
- Cape Canaveral Air Station (December 1998)
- Commercial Dry Cleaning Site in Florida (January 1999)

GeoVis™ Soil Imaging System:
- R-Reactor Seepage Basins at the SRS (November 1998)
- Cape Canaveral Air Station (December 1998)

SEA Cone Permeameter:
- Old Burial Ground and 321-M at the SRS

ARA Geophysical Tomography:
- TNX at the SRS (September 1998)
- EIC Internal Reflectance Probe
- 321-M at the SRS
- Commercial Dry Cleaning Site in Florida

GeoProbe Membrane Interface Probe:
- Evaluation planned for June 1999



Raman and Fluorescence Spectra Collected in M Area at the Savannah River Site (SRS)

FY 1999 Innovative Technology Summary Reports

- Enhanced Spectral Gamma Probe
- Bladon Lysimeter
- SEA Cone Permeameter
- FLUTe Hydrophobic Sorbent Membrane

TECHNICAL TASK PLAN (TTP) INFORMATION

TTP No./Title: SR16C221 - Site Characterization and Analysis Penetrometer System (SCAPS) Logistics and Dense Non-Aqueous Phase Liquid (DNAPL) Characterization

Related TTP No./Title: SR18SS32 - Applied DNAPL Characterization Methods, and SR17C221 - Development and Deployment of Innovative DNAPL Characterization Methods. The investigators on these tasks have collaborated successfully for many years, and many useful technologies have emerged from these leveraged efforts.

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